A WORLD-WIDE BAROMETRIC SEE-SAW.

In the year 1902, an account was given in this Journal (vol. lxvi. p. 248) of a short period atmospheric barometric variation which appeared to be closely related to the changes in the percentage frequency of prominences as observed year by year on the limb of the sun. In a later article, which appeared in the following year (vol. lxvii. p. 224), it was shown that this barometric variation consisted really of a great see-saw between two nearly antipodal parts of the earth, the one region about India and its neighbourhood behaving in an inverse way to that of South America and the southern parts of the United States. A further study of these pressure changes has recently been communicated by Sir Norman Lockyer and the writer to the Royal Society, the object being to trace the behaviour of these variations in as many regions of the earth's surface for which observations covering a sufficient period of time are available.

For this, so to speak, classification of pressure variation types, the system adopted was to take the pressure variations over India and Cordoba as the chief types of each region, denoting those of the former by the symbol (+), and those of the latter by (−). The pressure curve of any other place was then taken and compared with each. If, for example, it was found that the curve extending over several years exhibited an excess pressure at those epochs when the Indian pressure curve was in excess, then it was classified as being similar to the Indian type and represented by a (+). If it was seen that although it was more like the Indian curve than that of Cordoba, but yet not quite the exact counterpart of India, then it was denoted by (+ ?). In a similar way pressure curves like Cordoba were classified as (−), and those more like Cordoba than India as (− ?).

In some regions the pressure variation curves were distinctly a mixture of both the Indian and Cordoba types, and it was difficult to classify them satisfactorily by the above method. The symbol adopted for these cases was (± ?). Again, there were further some curves, but very few in number, in which even this mixed type of symbol was not sufficient to exhibit the relationship of their variations to the other curves, so a special symbol (?) denoting ambiguity was used.

It may here be mentioned that the pressure curves here utilised for discussion were not always formed from the values obtained by plotting the annual means, but from the means of the groups of consecutive months in which the pressure was above or below the yearly mean value. Such a division of the year can be accurately determined for places which have a regular and pronounced annual pressure variation, such as India, and where the yearly barometric range is of far greater magnitude than any other aperiodic fluctuation. In those regions where the mean yearly curve is more misleading than otherwise, such as the case of the British Isles, the divisions according to the two seasons included in the two groups of months, April to September and October to March, were adopted.

In examining the curves for the similarity or dissimilarity of the pressure changes, it was found that the special types were apparent sometimes in the yearly curves, sometimes in those for one or other of the high or low pressure groups of months, or sometimes in both of these. It did not, however, appear to follow that, because the type was distinguishable in the yearly curves, it was necessarily apparent in both the curves of the high and low pressure months.

On the accompanying map of the world are marked the types of pressure variations in each region included in this barometric survey.

Although the above classification gives a very fair idea on the whole of the types of pressure variations from one region to another, minor peculiarities have been met with which have tended to add a certain amount of difficulty. These remarks apply principally to places in the more northern latitudes. Thus, for instance, Greenland and Iceland have been classified as of the (+ ?) type, the British Isles, Germany, and Spain of the (± ?) type, and the Azores of the (− ?) type.

While the western portion of Europe is of the (± ?) type, the eastern portion gradually assumes the (− ?) type, and this region extends not only probably to Norway and Sweden, but right across European and Asiatic Russia. The European Russian type of curve has an undoubted similarity to those of more western Europe, but there are variations which indicate that the type is more like that of Cordoba than India.

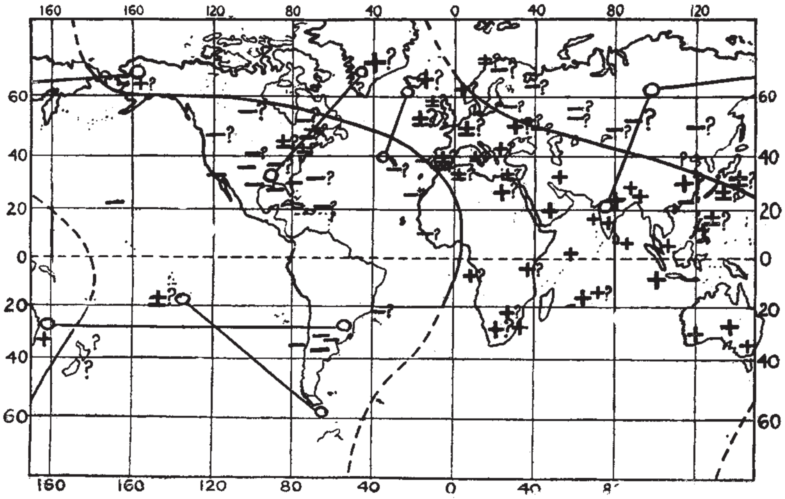

Fig. 1.—Showing the distribution of the different types of pressure variation. The two main regions are roughly separated by the neutral lines. Previously known "see-saws" are shown by the short continuous straight lines connecting the two regions marked with small circles.

Again, another region in which rather mixed types of pressures are met with is that of eastern and north-eastern Canada. Curiously enough, Prince Edward Island and Sydney (Nova Scotia) correspond very closely to the (-) type, if allowance be made for the differences about the year 1877. The inverted curve for the latter with the Adelaide (Australia) pressure curve for comparison is shown in Fig. 2.

In addition to illustrating this reversal between Adelaide (+) and Sydney (Nova Scotia) (− ?), this figure shows also, to serve as examples, curves for two other sets of reverse pressure conditions. Thus, Bombay (+) is compared with the Cordoba (−) pressure curve (inverted), and is an example of the adopted types of pressure variation. Iceland is compared with that of the Azores (inverted), and shows the reverse conditions that prevail between a (+ ?) type and a (− ?) type.

A fact to which attention was very often directed

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in attempting to classify the pressure curves was that some curves, after following very closely for many years the Cordoba (–) or Indian (+) type of pressure, as the case may be, would revert back to the opposite type for a period of years. Thus, to take the case of one station alone, namely, Sydney (Nova Scotia), as an instance, the pressure curve follows very closely that of India from 1874–1882, after which, up to 1890, it has a very close resemblance to the Cordoba type. The behaviour of this Sydney (Nova Scotia) pressure curve can be compared with the Adelaide (Australia) curve in Fig. 2, but it must be noticed that the former has here been *inverted*.

The accompanying map (Fig. 1) shows the result of an attempt to indicate the position of a neutral line to illustrate approximately the mean lines of separation of these two chief pressure types, although it must be remembered that this line is liable to a probable small oscillation about its mean position.

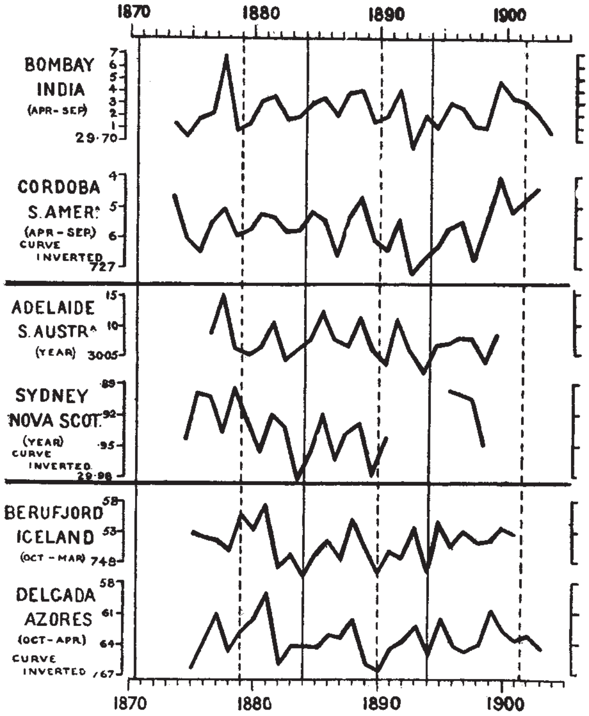

Fig. 2.—Showing the two main types of pressure variation as illustrated by Bombay (+), Cordoba (–), and the barometric relationships between Adelaide and Sydney (Nova Scotia) and between Iceland and the Azores.

So far as can at present be determined, one line commencing to the west of Alaska, separating this region from Siberia, passes easterly along about the 60° parallel of latitude, and runs in a south-easterly direction between south-west Greenland and north-east Canada. It then crosses the North Atlantic, passing to the north of the Azores, and skirts the south-western portion of Portugal. It then strikes down towards the Equator, cutting north-west Africa, so far as can be judged from the scant pressure values available, through the middle of the Sahara. It leaves Africa near the Gold Coast, and passes into the South Atlantic, where it cannot be traced further owing to lack of observations in this southern ocean.

The other boundary or neutral line passes to the north-east of Greenland and north of Iceland, crosses the southern portion of Norway and Sweden, and traverses southern European Russia. It then takes a course somewhat more easterly, skirting the northern part of the Caspian Sea and Turkestan, passes between Tibet and Mongolia, and through China. It then leaves the continent a little to the south of the Yellow Sea, and passes into the North Pacific Ocean. Here its path cannot be traced, but it evidently passes well to the east of the Philippine Islands, and Solomon Islands, takes a new south-westerly course, skirting the eastern side of Australia and passing between Tasmania and New Zealand. Its track is then again lost in the southern Pacific Ocean.

Although too much weight must not at present be given to the positions of these neutral lines throughout their whole length, it is interesting to note that they are fairly symmetrical to one another, although no attempt has been made to make them so. Both lines apparently cross the equator at about antipodal points, and both appear to have a similar trend in northern and southern latitudes.

The result of this survey seems to indicate clearly that there exists a general law relating to the pressure changes which occur simultaneously in these two extensive regions of the globe, separated and defined more or less by a neutral line, this latter forming a fulcrum about which see-saws of pressure from one region to another take place.

Special cases of such reverse pressure variations have previously been noticed, chief among which are those detected by Blandford, Hildebrandsson and Hann.

To illustrate these cases in relation to the present work, there have been drawn on the map (Fig. 1) small circles connected by lines to show their relation to the neutral line. A single glance is sufficient to see that in all cases except one the see-saws occur in places lying on opposite sides of the neutral line.

These results thus agree well in the main with the present distribution of the regions which have been examined.

Quite recently Prof. Bigelow, working on the same lines as those indicated in the present research, published a map of the world on which he has indicated the distribution of the pressure types according as they follow the Indian (or direct type as he calls it) or the Cordoba (indirect) pressure variations. In most of the main features, however, his map suggests a somewhat similar distribution of these pressure types to that given here. Thus, he finds that "the region around the Indian Ocean gives direct synchronism, South America and North America give inverse synchronism, while Europe and Siberia give an indifferent type. Greenland and Iceland seem to have direct type like the Indian Ocean. . . . The eastern hemisphere tends to direct synchronism, except in Europe and Russia where the indifferent type prevails, and the western hemisphere to the inverse type."

It may be mentioned in conclusion that regions which are the reverse of one another as regards these secular pressure variations should very probably experience opposite kinds of abnormal weather, while those over which the same type of pressure variation exists should have weather of an abnormal but similar nature. The intimate connection between pressure and rainfall, allowing for the local conditions as regards situation for the latter, suggests that the variation of rainfall should be closely studied in relation to this barometric surge, and it is in this way that progress may be looked for with regard to monsoon and other seasonal forecasts.

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